Envisioning the Future

Progress on the Strategic Plan 2015-2020; Planning for 2020 – 2025; and Beyond

Meeting between the HEI Research Committee and Sponsors

March 4, 2019; 12:00 to 4:00 pm

https://zoom.us/j/724632307

HEI

Trusted Science • Cleaner Air • Better Health

Our Agenda Today

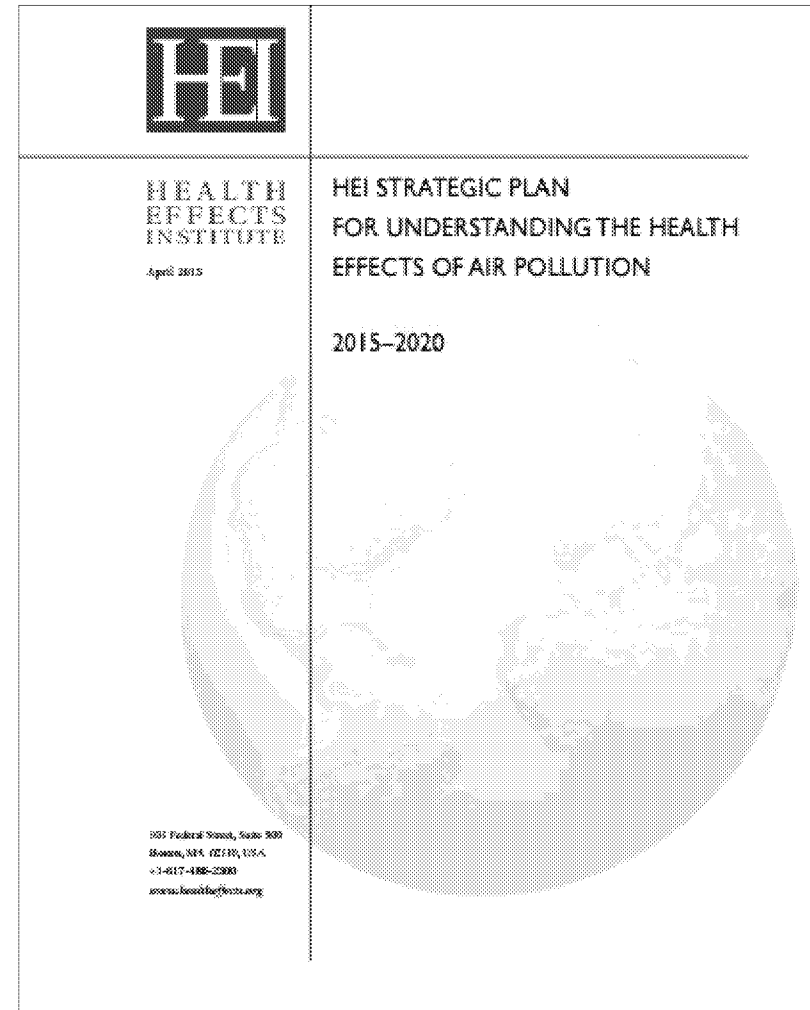|	
12:00	Lunch with HEI Research Committee, sponsors and staff
1:00	Opening comments – Dan Greenbaum
1:10	Moving Key Strategic Plan Projects Forward: Year Four Progress and Year Five Plans:
	--- Addressing the Challenges of Multi-Pollutant Science
	--- Accountability and Transparency
	--- New Fuels and Technologies
	--- Global Health Science
1:45	Envisioning the Future: Building the HEI Strategic Plan 2020 – 2025
	--- The Challenges Ahead
	--- Emerging and Potential New Science
2:15	Questions and Discussion : *What do HEI's Sponsors Think the Priorities Should Be?*
2:45	Sponsor comments
	--- Alan Vette – EPA
	--- Susan Collet – Toyota
	--- Tim Wallington – Ford
	--- Bruce Copley – ExxonMobil
	--- Others
3:30	Progress on HEI's Initiative on Oil and Gas Development
3:45	Follow-up and Next steps
4:00	Adjourn and refreshments

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HEI's Strategic Plan 2015-2020

Guides HEI's research and review activities;

Responds to the needs of HEI industry & government sponsors, and other interested parties;
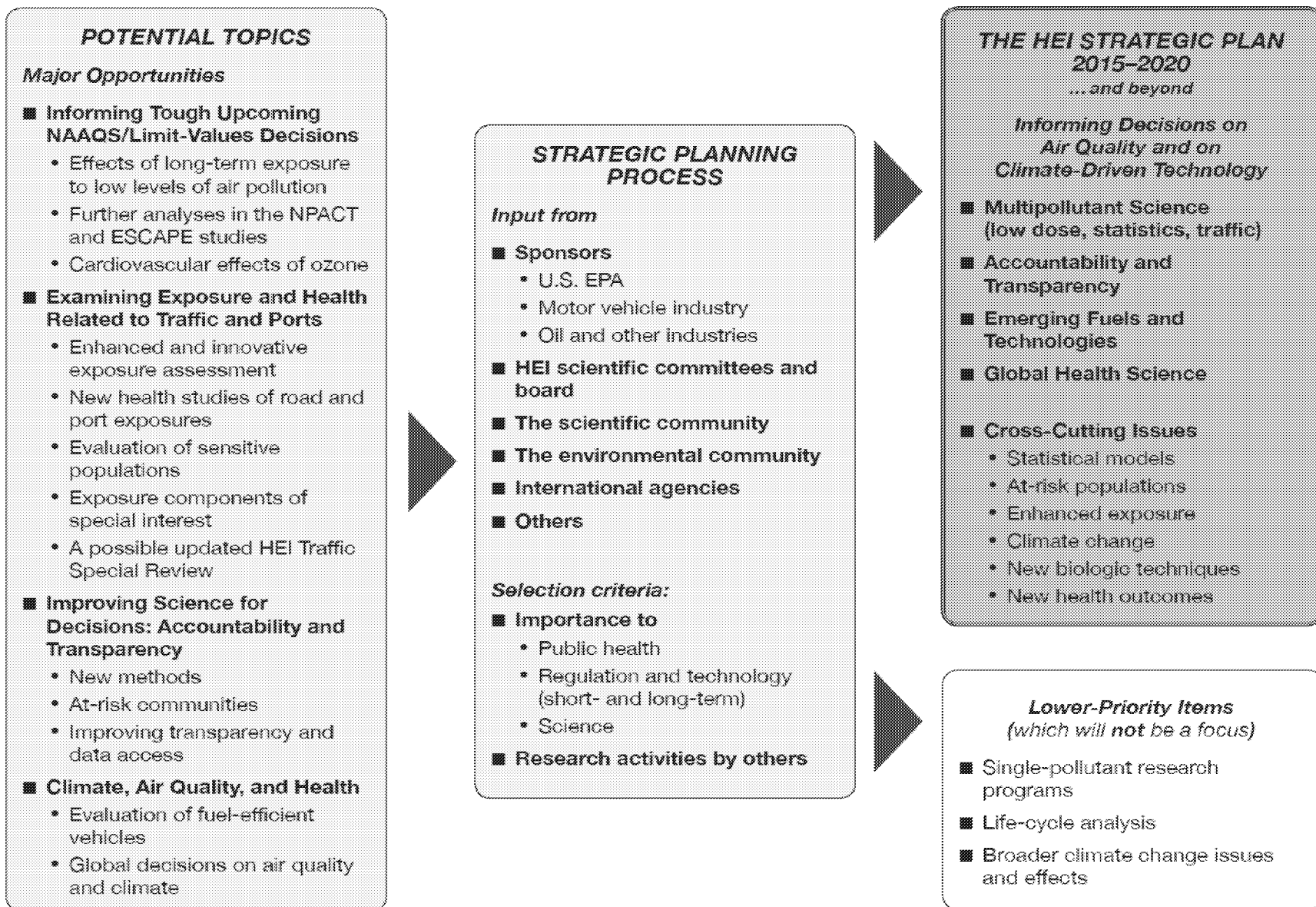
Anticipates future policy and technology events; and,

Evolves over time to adapt to changing knowledge and events

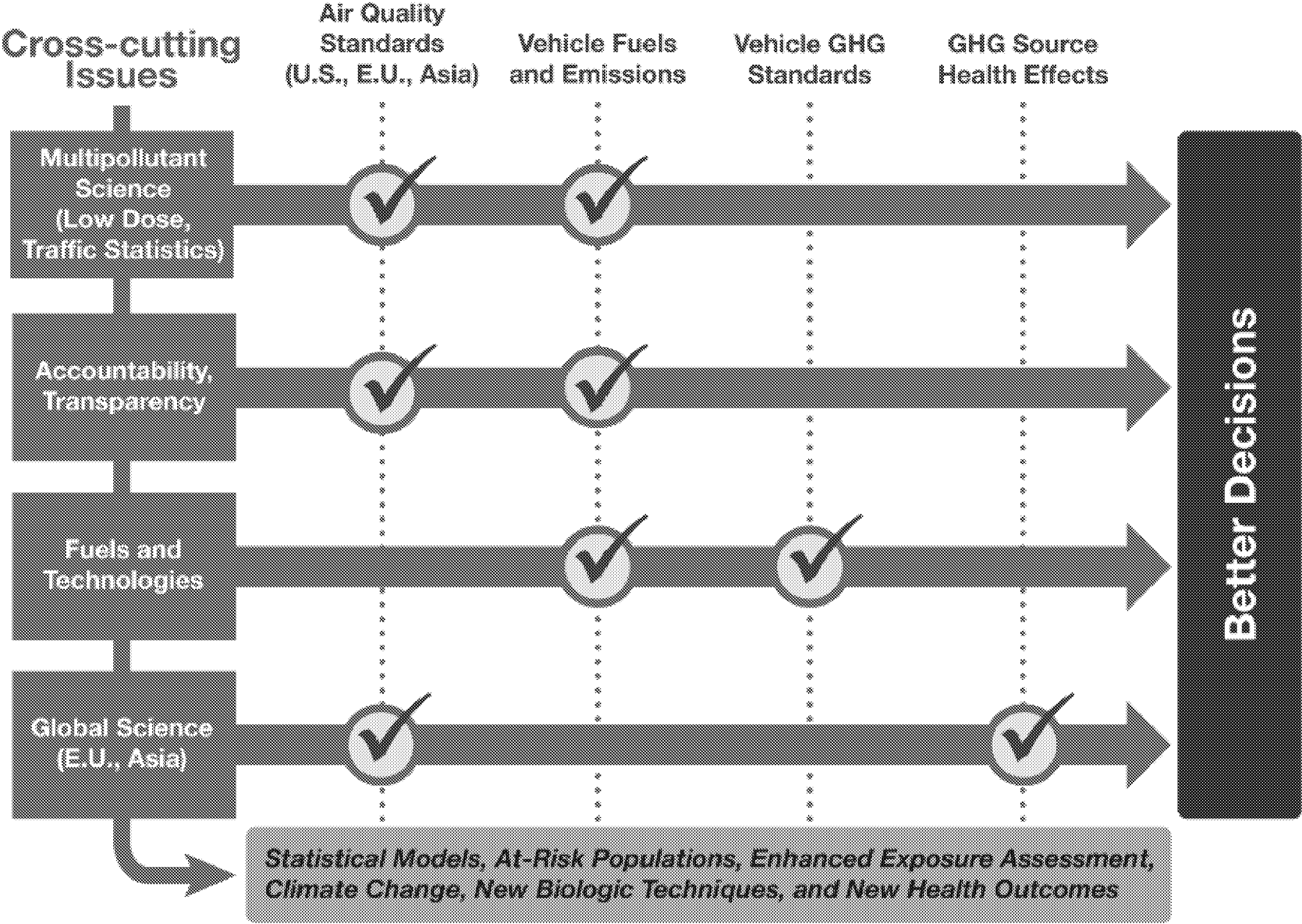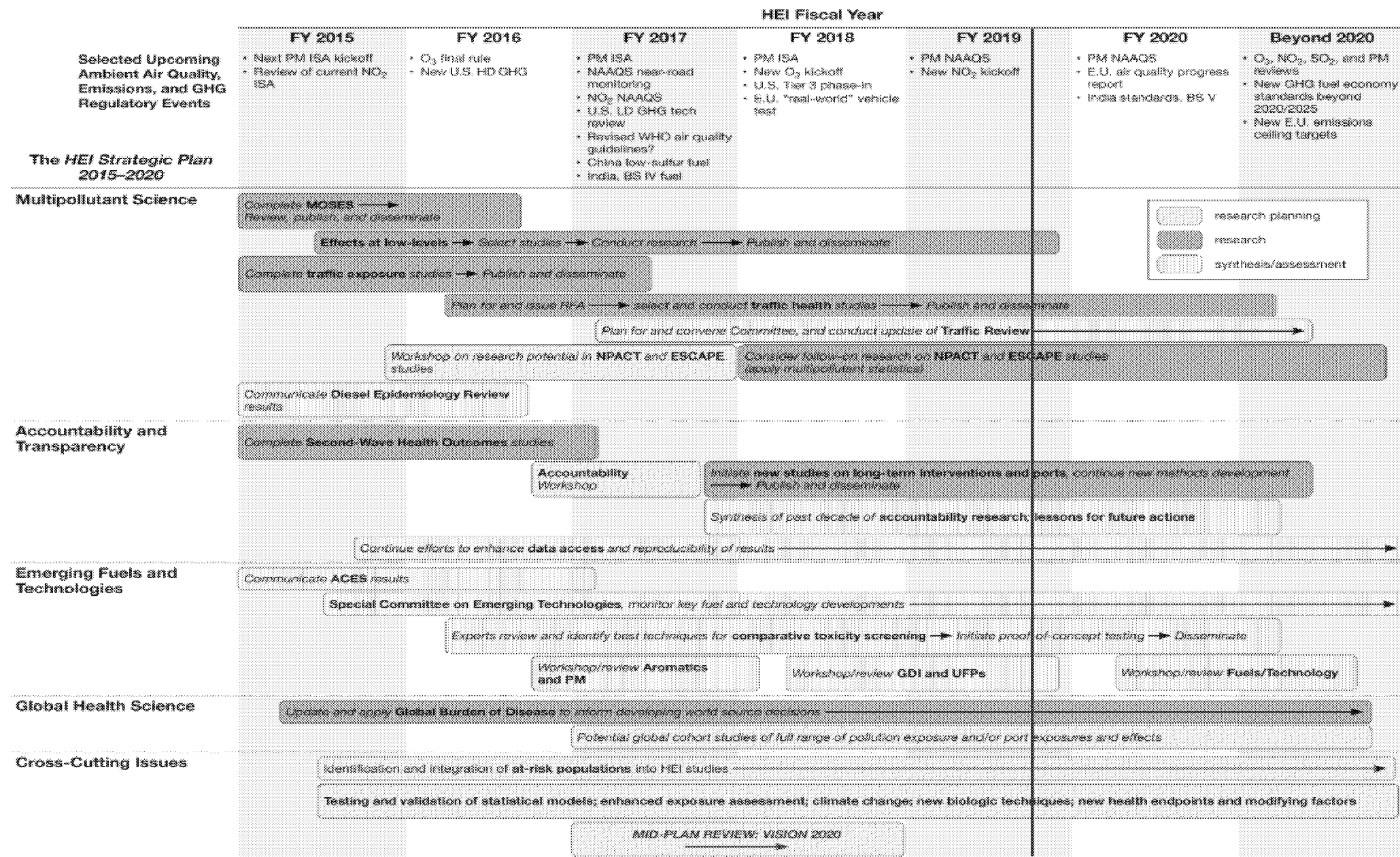Thank you for your ongoing feedback as we implement the Plan

HEALTH EFFECTS INSTITUTE

April 2015

HEI STRATEGIC PLAN
FOR UNDERSTANDING THE HEALTH EFFECTS OF AIR POLLUTION

2015–2020

Choosing the Future

POTENTIAL TOPICS

Major Opportunities

- **Informing Tough Upcoming NAAQS/Limit-Values Decisions**
  - Effects of long-term exposure to low levels of air pollution
  - Further analyses in the NPACT and ESCAPE studies
  - Cardiovascular effects of ozone

- **Examining Exposure and Health Related to Traffic and Ports**
  - Enhanced and innovative exposure assessment
  - New health studies of road and port exposures
  - Evaluation of sensitive populations
  - Exposure components of special interest
  - A possible updated HEI Traffic Special Review

- **Improving Science for Decisions: Accountability and Transparency**
  - New methods
  - At-risk communities
  - Improving transparency and data access

- **Climate, Air Quality, and Health**
  - Evaluation of fuel-efficient vehicles
  - Global decisions on air quality and climate

STRATEGIC PLANNING PROCESS

Input from

- **Sponsors**
  - U.S. EPA
  - Motor vehicle industry
  - Oil and other industries
- **HEI scientific committees and board**
- **The scientific community**
- **The environmental community**
- **International agencies**
- **Others**

Selection criteria:

- **Importance to**
  - Public health
  - Regulation and technology (short- and long-term)
  - Science
- **Research activities by others**

THE HEI STRATEGIC PLAN 2015–2020
... and beyond

Informing Decisions on Air Quality and on Climate-Driven Technology

- **Multipollutant Science (low dose, statistics, traffic)**
- **Accountability and Transparency**
- **Emerging Fuels and Technologies**
- **Global Health Science**

- **Cross-Cutting Issues**
  - Statistical models
  - At-risk populations
  - Enhanced exposure
  - Climate change
  - New biologic techniques
  - New health outcomes

Lower-Priority Items
(which will not be a focus)

- Single-pollutant research programs
- Life-cycle analysis
- Broader climate change issues and effects

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The *HEI Strategic Plan 2015–2020*... and beyond

Informing Decisions on Air Quality and on Climate-Driven Technology

Cross-cutting Issues	Air Quality Standards (U.S., E.U., Asia)	Vehicle Fuels and Emissions	Vehicle GHG Standards	GHG Source Health Effects	
Multipollutant Science (Low Dose, Traffic Statistics)	✓	✓			**Better Decisions**
Accountability, Transparency	✓	✓			
Fuels and Technologies		✓	✓		
Global Science (E.U., Asia)	✓			✓	

Statistical Models, At-Risk Populations, Enhanced Exposure Assessment, Climate Change, New Biologic Techniques, and New Health Outcomes

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Implementation of the Strategic Plan 2015 – 2020

HEI Fiscal Year

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	Beyond 2020
Selected Upcoming Ambient Air Quality, Emissions, and GHG Regulatory Events	• Next PM ISA kickoff • Review of current NO₂ ISA	• O₃ final rule • New U.S. HD GHG	• PM ISA • NAAQS near-road monitoring • NO₂ NAAQS • U.S. LD GHG tech review • Revised WHO air quality guidelines? • China low-sulfur fuel • India, BS IV fuel	• PM ISA • New O₃ kickoff • U.S. Tier 3 phase-in • E.U. "real-world" vehicle test	• PM NAAQS • New NO₂ kickoff	• PM NAAQS • E.U. air quality progress report • India standards, BS V	• O₃, NO₂, SO₂, and PM reviews • New GHG fuel economy standards beyond 2020/2025 • New E.U. emissions ceiling targets

The *HEI Strategic Plan 2015–2020*

Legend:
- research planning
- research
- synthesis/assessment

Multipollutant Science

- Complete **MOSES** → Review, publish, and disseminate
- Effects at low-levels → Select studies → Conduct research → Publish and disseminate
- Complete **traffic exposure** studies → Publish and disseminate
- Plan for and issue RFA → select and conduct **traffic health** studies → Publish and disseminate
- Plan for and convene Committee, and conduct update of **Traffic Review**
- Workshop on research potential in **NPACT** and **ESCAPE** studies → Consider follow-on research on **NPACT** and **ESCAPE** studies (apply multipollutant statistics)
- Communicate **Diesel Epidemiology Review** results

Accountability and Transparency

- Complete **Second-Wave Health Outcomes** studies
- **Accountability Workshop** → Initiate new studies on long-term interventions and ports, continue new methods development → Publish and disseminate
- Synthesis of past decade of accountability research, lessons for future actions
- Continue efforts to enhance **data access** and reproducibility of results

Emerging Fuels and Technologies

- Communicate **ACES** results
- **Special Committee on Emerging Technologies**, monitor key fuel and technology developments
- Experts review and identify best techniques for **comparative toxicity screening** → Initiate proof-of-concept testing → Disseminate
- Workshop/review **Aromatics and PM**
- Workshop/review **GDI and UFPs**
- Workshop/review **Fuels/Technology**

Global Health Science

- Update and apply **Global Burden of Disease** to inform developing world source decisions
- Potential global cohort studies of full range of pollution exposure and/or port exposures and effects

Cross-Cutting Issues

- Identification and integration of **at-risk populations** into HEI studies
- Testing and validation of statistical models; enhanced exposure assessment; climate change; new biologic techniques; new health endpoints and modifying factors

MID-PLAN REVIEW: VISION 2020

Estimating the Health Effects of Exposure to Low Levels of Air Pollution

○ Three studies, with key features:

  - Populations with millions in the US, Canada ,and Europe; administrative and traditional cohorts
  - Satellite data and ground level exposure measurements; high quality exposure assessment models at high spatial resolutions

○ Development and application of novel statistical methods

○ Investigator teams with prior experience of productive collaborations

Figure 1 Shape of Canadian Concentration-Response Function
(From Burnett 2013 drawn from Crouse 2012)

New US
WHO
CAAQS
Old US
70% Canadian Population
50% Pop
GBD
Not Sure of Effects Below this Level
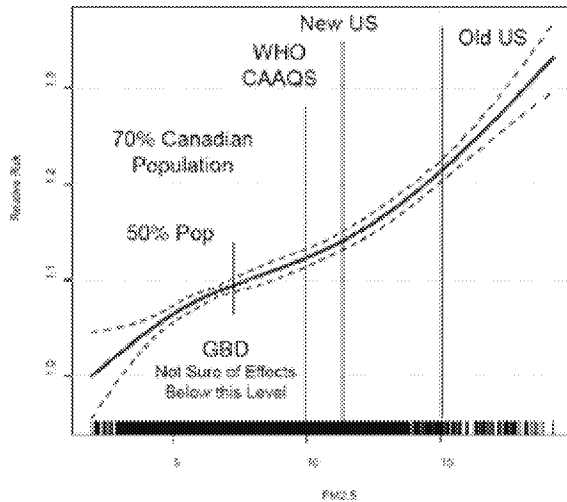
New HEI studies assessing health effects of low levels of air pollution

Geographical areas

PI: Michael Brauer, U British Columbia (~ 6 million)

PI: Francesca Dominici, Harvard (~ 60+ million)

PI: Bert Brunekreef, Utrecht (~25 million)

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Ensuring the Highest Quality from the Low Exposure Studies

- US and Canadian Studies half-way through; European study 75% complete

- Detailed and continuing HEI oversight
  --Oversight Committee:
    - Progress reports every 5 months
    - Annual, detailed renewal requests
    - Webinars and annual meeting
    - *Substantive review at each stage*
  --QA/QC audits

- Session during the 2019 Annual Conference in Seattle: (Monday, May 6, 2019): All three teams presenting results. Also comments by special HEI Review Panel

- <u>Six</u> poster presentations at the Annual Conference on Monday, May 6, 2019

- Final Reports – after review, to be published with commentaries during 2021-2022

Phase 1 Reports and Review

- EPA – Expedited NAAQS revisions in progress for $PM_{2.5}$ and Ozone

- Dominici and Brauer – Early results published in journals, while additional work is on-going

- HEI requested Phase 1 reports, summarizing results to-date

- HEI formed special Review Panel, with Sverre Vedal (chair, University of Washington) plus six additional experts in epidemiology, exposure assessment and biostatistics

- Reviews in progress

- Reports and Panel commentary to be published during spring 2019, with aim to inform NAAQS process

Effect of Ozone on the Cardiovascular System:
The MOSES Study

- HEI's Multicenter Ozone Study in oldEr Subjects

- HEI's detailed report, along with Commentary, published in June 2017

- Peer-reviewed papers:
  - Respiratory endpoints: *American Journal of Respiratory and Critical Medicine* (2018)
  - Cardiovascular endpoints: *Environment International* (2018)

- Study data, and limited number of samples, made available in 2018

- Phase 2 analyses: Focuses on impacts of personal and ambient concentrations of ozone and other pollutants on cardiovascular and pulmonary function

- Report received, under review

- Publication expected in early 2020

Exposure to traffic related air pollution and health

- **High priority area in the Strategic Plan, with three components:**

  - Complete, review and publish several on-going studies

  - Launch new research: health effects investigations with emphasis on confounders

  - Revise and update the earlier literature review

Exposure to Traffic-Related Air Pollution

From earlier in the Strategic Plan 2015-2020: Several studies completed and in review and publication stages:

- Hong Kong: 3D study in street canyons (Barrett) (published)

- Atlanta: Exposures of students living in dorms in the vicinity of roads (Sarnat) (published)

- Oakland: Use of sensor technology (Seto) (unpublished)

- Traffic Tunnels in Hong Kong and Baltimore (Wang) (in press)

- Enhanced statistical modeling (Batterman) (in press)

- Spatial and temporal variance of near road exposures (Frey) (in review)

- A study of tire and brake wear – (Koutrakis) (in progress)

Baltimore

Ft. McHenry

Port of Baltimore

Fort McHenry Tunnel Study

Vehicle Emissions in tunnels in Hong Kong and Baltimore

- Emissions studied in two tunnels: the Shing Mun Tunnel in Hong Kong and the Fort McHenry Tunnel in Baltimore;

- Data from earlier studies available for comparison

- In 2015, both tunnels had lower emissions from light-duty and heavy-duty vehicles for most pollutants compared to earlier studies in the same tunnels

- Mid-March publication

- Sponsor briefing planned

- Data will be made available
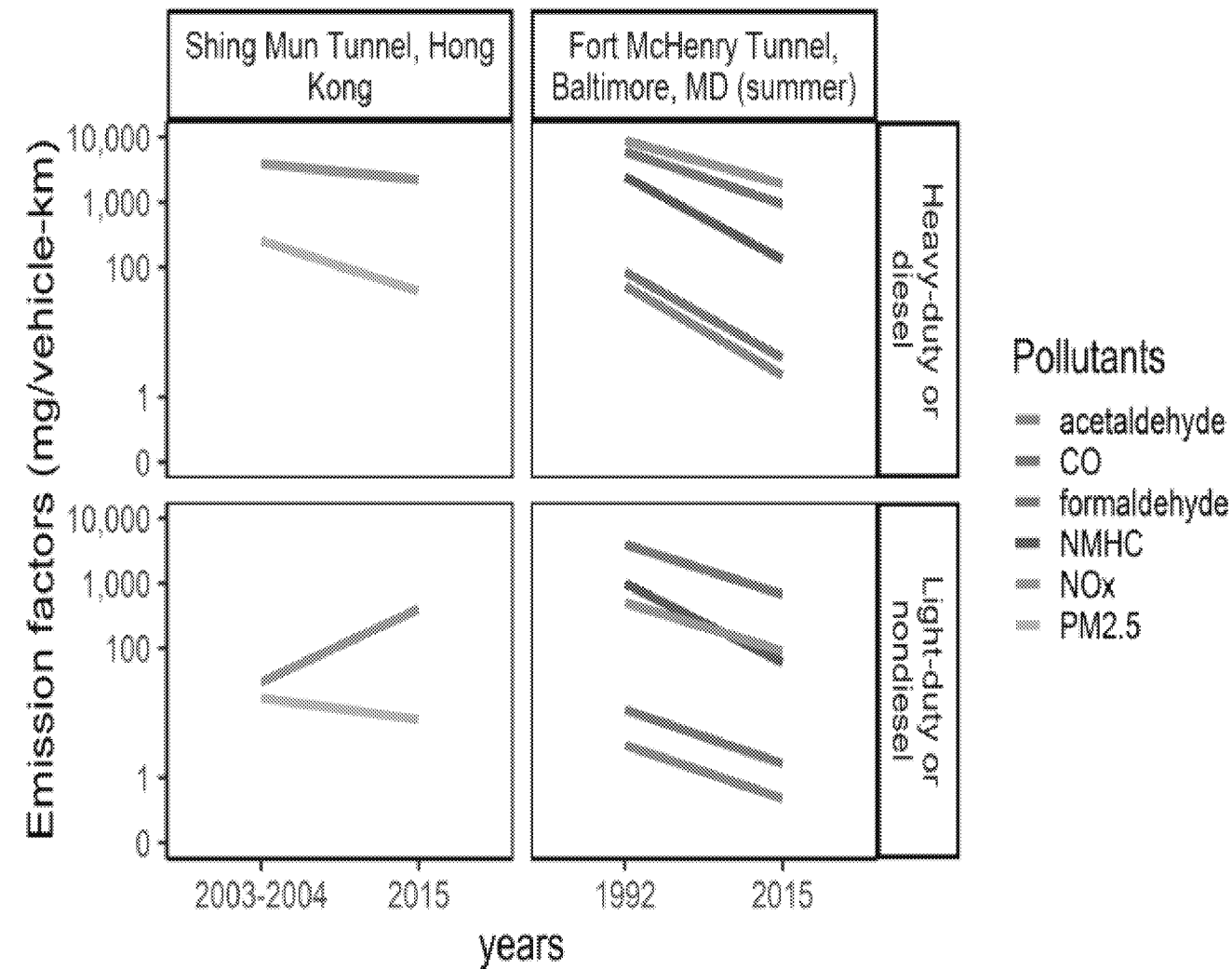
From Wang et al., 2019 (in press)

The Next Phase of Traffic Research

- 2017 RFA: *Assessing Adverse Health Effects of Exposure to Traffic-Related Air Pollution, Noise, and Their Interactions With Socio-Economic Status*

- New studies funded:
  - Traffic-related air pollution and birth weight (Dadvand and Sunyer, ISGlobal)
  - Non-tailpipe emissions and noise from traffic and children's health (Franklin, University of Southern California)
  - Air pollution components, noise and socio-economic status (Raaschou-Nielsen, Copenhagen University)
  - Scalable multi-pollution exposure assessment using routine mobile monitoring platforms (Josh Apte, University of Texas, Austin) [Rosenblith Investigator]

- Studies started in 2018 – Three year studies + time for review and publication

Traffic-related air pollution, noise and birth weight

Dadvand and Sunyer (ISGlobal):   Setting up a new cohort of healthy pregnant women in *Barcelona*, Spain (N ~1200)

Traffic-related air pollution and birth weight: the roles of noise, placental function, green space, physical activity, and socioeconomic status (FRONTIER)

Payam Dadvand[1] & Jordi Sunyer[1], Maria Dolores Gómez-Roig[2], Gustavo Arévalo[3], Xavier Basagaña[1], Maria Foraster[1], Michael Jerrett[4], Jose Lao[3], Edurne Mazarico Gallego[2], Teresa Moreno[5], Tim Nawrot[6], Mark J Nieuwenhuijsen[1], Xavier Querol[5], Joel Schwartz[7], Cathryn Tonne[1]

1 ISGlobal, Barcelona, Spain;   2 BCNatal, University of Barcelona, Barcelona, Spain;   3 Barcelona Regional, Barcelona, Spain;   4 Fielding School of Public Health, University of California, Los Angeles, Los Angeles, California, USA;   5 IDAEA-CSIC, Barcelona, Spain; 6 Centre for Environmental Sciences, Hasselt University, Diepenbeek, Belgium;   7 Harvard School of Public Health, Cambridge, Massachusetts, USA.

The Next Phase of HEI Traffic Research
Air pollution components, noise, socio-economic status and cardiovascular health

Raaschou-Nielsen, Danish Cancer Society Research Center, using existing cohorts in Denmark: AN administrative cohort (N=5.5 million) and the Diet Cancer & Health Next Generation cohort (N=50,000)

Health effects of air pollution components, noise and socio-economic status ("HERMES")

Ole Raaschou-Nielsen[1,3], Theis Lange[2], Matthias Ketzel[3], Ulla Hvidtfeldt[1], Henrik Brønnum-Hansen[2], Thomas Münzel[4], Ole Hertel[3], Jørgen Brandt[3], Mette Sørensen[1,5]

HERMES
God of transportation, roads and travelers

Introduction

Traffic-related air pollution (TRAP), traffic noise and low socio-economic status (SES) impair health. Uncertainty remains about the causal TRAP component(s), the most relevant timing of exposure, the degree of confounding and possible interaction with traffic noise, socio-economy and individual susceptibility.

Aims

- to identify the specific TRAPs strongest associated with myocardial infarction (MI), stroke and diabetes
- to disentangle how TRAP and road traffic noise interact in relation to these endpoints
- to investigate how socio-economic status (SES), green spaces, co-morbidity and stress confound/interact with the associations between TRAP and road traffic noise and risk of MI, stroke and diabetes
- to investigate effects of TRAP and road traffic noise in relation to cardiovascular and metabolic biomarkers

The Next Phase of HEI Traffic Research
Non-tailpipe emissions and noise and children's respiratory health

Meredith Franklin, University of Southern California , Building on the Children's Health Study in *Southern California* (N=5000); includes non-tail pipe emissions

Intersections as hot spots: Assessing the contribution of localized non-tailpipe emissions and noise on the association between traffic and children's health

Meredith Franklin, Rob McConnell, Robert Urman, Scott Fruin

University of Southern California, Los Angeles, CA

University of Southern California

Particulate Matter Air Pollution: The Intra-Community Variability (ICV) Study

In the eight Southern California communities, monitoring of quasi-ultrafine (<0.2 um), fine and coarse (2.5 to 10 um) PM was conducted using modified Harvard Cascade Impactors at homes and schools of participating children in month-long integrated samples in the cool (Oct-Mar) and warm (Apr-Sep) seasons. Chemical speciation was conducted on each size fraction, providing a unique spatially rich dataset (Figure 2). For more detail see Fruin et al. [1]

Noise

The most recent version of the U.S. Federal Highway Administration (FHWA) Traffic Noise Model (TNM) version 2.5 uses roads, traffic volume, posted road speeds, pavement type, and vehicle type (cars, heavy trucks, light trucks, buses and motorcycles) to estimate traffic noise in decibels (Figure 3). We will supplement the modeled data with measurements at different road types and intersections in the 8 ICV communities using two 2238 MediatorTM, Class 1 Integrating Sound Level noise meters manufactured by Brüel & Kjær.
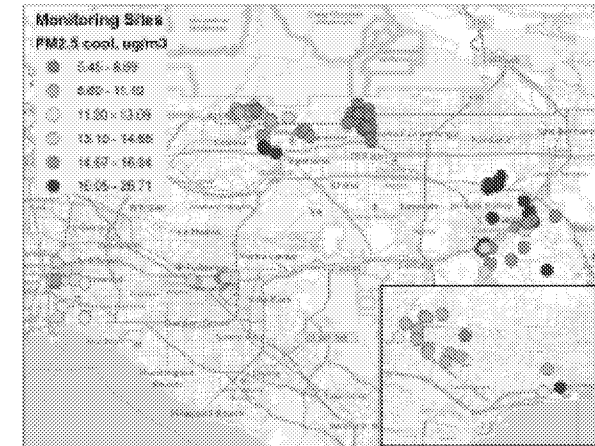
Figure 2. Map of study region: the ICV

The Next Phase of HEI Traffic Research
Scalable multi-pollution exposure assessment using routine mobile monitoring platforms

Josh Apte (University of Texas, Austin): Builds on and furthers research in West Oakland, and applications in Bengaluru, India

What Can We Learn From Mobile Air Pollution Measurements?
Validation, Comparison, and Data Mining

The 100×100 Study: comparing mobile and fixed measurements

In Summer 2017, more than 100 fixed-site black carbon (BC) samplers were deployed for 100 days in West Oakland, CA. Monitors were sited at a mixture of residential and commercial properties. Sampling sites were chosen to incorporate a diverse array of land uses, including up-wind sites and locations near industries, busy roads, and a major port. Measurements were made using a novel low-cost light absorption BC sensor, the Aerosol Black Carbon Detector (ABCD, Caubel et al., 2018), which was extensively validated against reference techniques.

During the 100×100 campaign, two Google Street View (GSV) cars repeatedly sampled every city street in West Oakland on 35 distinct days, collecting over 330 h of measurements, and repeatedly passing each of the fixed ABCD monitoring sites. We devised three approaches to comparing mobile and fixed measurements:

* Laboratory co-location: We co-located 3 ABCD sensors next to the night-time parking

Source identification: temporal and chemical signatures

Using existing data collected with Google Street View cars in Oakland, we will test whether we can identify spatial and temporal emissions source signatures by applying time series data mining techniques to mobile measurements. For example, Figure 3 separates local traffic emissions peaks from the ambient background. To validate these findings, we will compare data-mined patterns to a spatially resolved PM source apportionment derived from a specially equipped mobile laboratory with a high-resolution aerosol mass spectrometer (HR-AMS) that was used in Oakland in concert with the GSV cars in Summer 2017 (Figure 4-5).
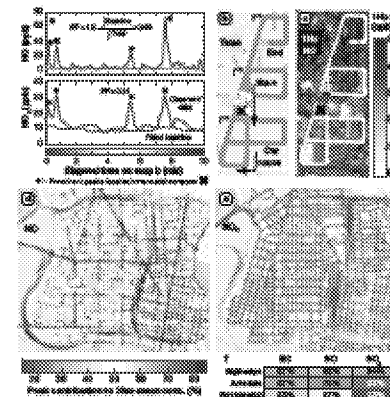
Figure 4. As part of the EPA Center for Air, Climate and Energy Solutions, Carnegie Mellon's "Breathemobile" mobile lab joined the Oakland sampling campaign in Summer 2017.

Figure 3. Identification of localized concentration peaks using time-resolved GSV measurements. a. Example 10 min time series of NO and NO_2. Baseline fitting algorithm decomposes measurements (solid traces) into an ambient

Review of the Traffic Literature

- HEI published a comprehensive review in 2010, highly downloaded

- Strong interest in an update of the review from sponsors → 2015-2020 Strategic Plan
  - Substantial new research published
  - Also, trends in mobile source pollution, as regulations and technologies have advanced, and their potential implications

- HEI appointed a new panel to *systematically review*, new epidemiologic studies: health endpoints, exposures, effects of noise, SES, green space.
  - Panel formed after request for nominations from sponsors and others

- Panel has developed a specific protocol and other instruments, and began literature searches and data extraction.

- Intensive work will continue during 2019; report ready by mid-2020

- After peer-review, target publication in late 2020

A flood of additional health studies have been published

Example Pubmed search (from jan 1 1980- dec 31 2017)
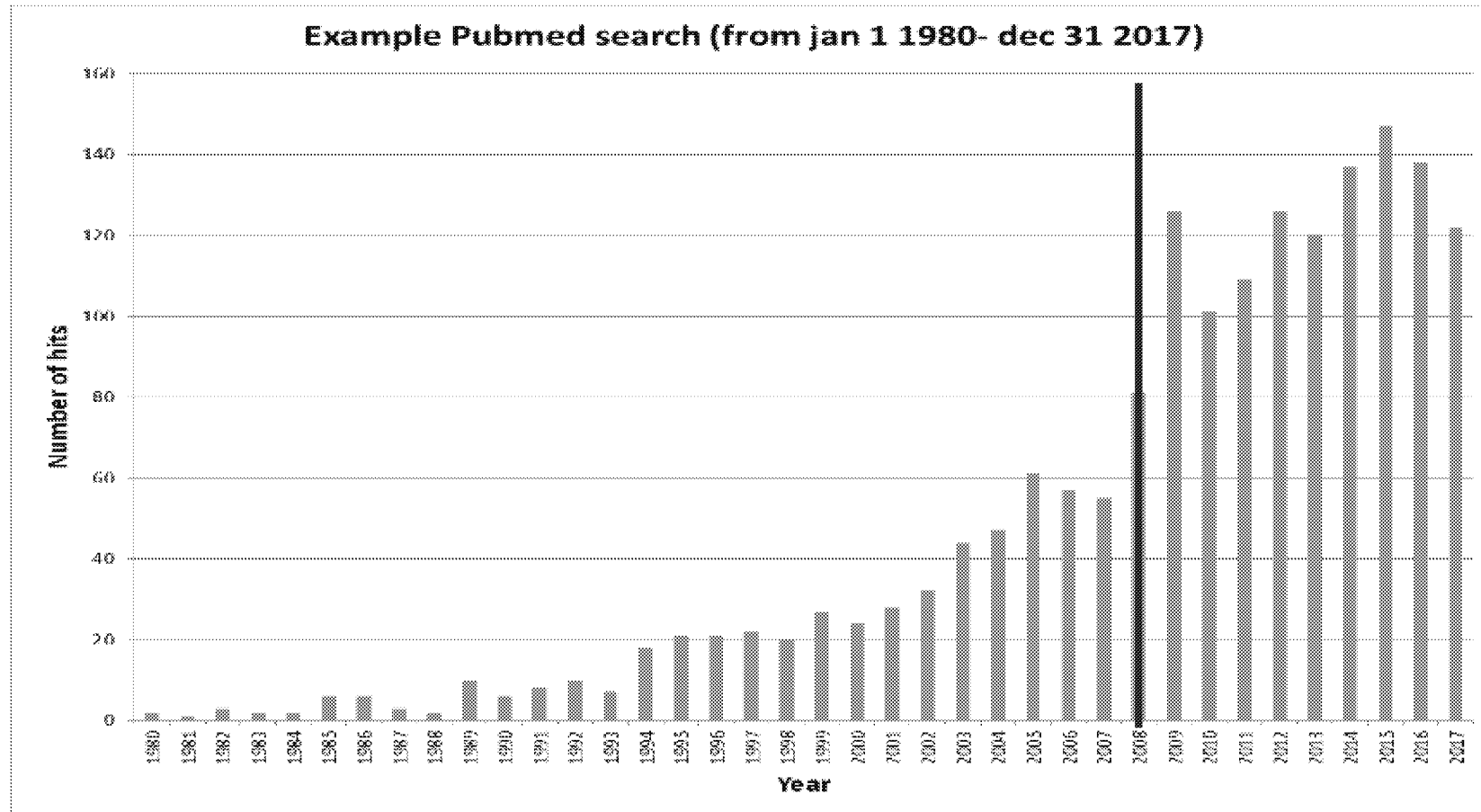
Members of the HEI Panel to Review the Traffic Literature

Francesco Forastiere, Co-Chair (King's College London, UK)

Frederick Lurmann, Co-Chair (Sonoma Technology, Inc., Petaluma, CA)

Richard Atkinson (St George's, University of London, UK)

Jeffrey Brook (University of Toronto, Canada; Member Research Committee)

Howard Chang (Emory University, Atlanta)

Gerard Hoek (Utrecht University, Netherlands)

Barbara Hoffmann (University of Düsseldorf, Germany; Member Research Committee)

Sharon Sagiv, University of California, Berkeley

Audrey Smargiassi (University of Montreal, Canada)

Adam Szpiro (University of Washington, Seattle)

Danielle Vienneau (University of Basel, Switzerland)

Gregory Wellenius (Brown University, Providence)

Jennifer Weuve (Boston University, Boston)

New RFA: Applying novel approaches to improve long-term exposure assessment of outdoor air pollution for health studies

- Origin: A lot of interest in new (low-cost) sensors; and their applications for community science --- What should HEI do?

- HEI's Interest: How to harness new technologies for more precise health studies
  - Problem: Exposure assessment errors are one of the major limitations in air pollution epidemiology → incorrect risk values
  - Technologies: Sensors, mobile monitoring, location and activity tracking, other

- RFA focus: Long-term exposure to pollutants that exhibit high spatial and temporal variability (e.g., ultrafine particles, NOx, PM components, etc.)
  - Monitoring campaigns, modeling, analyses, to determine long term exposures
  - Quantify exposure measurement error, and
  - Actual or potential applications to health studies

- Thank you for your thoughtful comments

- Schedule: RFA to be issued later this month; new studies decisions in fall, studies to start in early 2020

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Accountability Research
Effectiveness of Environmental Regulations

- HEI has a long-term track-record of comprehensive research and reviews; 15+ publications

- Under a 2011 RFA, HEI funded four studies on large-scale, multi-year regulatory programs

  - <u>Zigler</u>: Statistical methods for causal inference (*published: 5/2016*)

  - <u>Gilliland</u>: Evaluating changes in children's health in Southern California (*published: 1/2017*)

  - <u>Russell</u>: Impacts of regulations on air quality and emergency department visits in Atlanta (*published:* 2018)

  - <u>Meng</u>: Goods movement regulations in California and health impact (*Phase 1 completed; Phase 2 – report expected soon; publication in 2020*)

Chain of Accountability
HEI diagram showing relationship of regulatory action to health effects of air pollution.

Regulatory action

Emissions

Ambient air quality

Exposure/dose

Human health
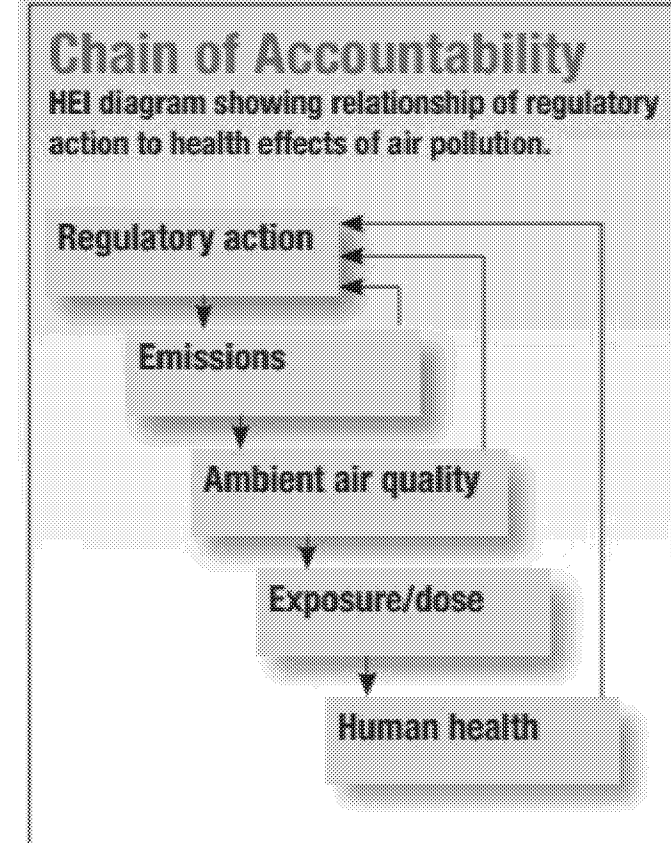
Accountability Research: New RFA 18-1

- New RFA: "Assessing improved air quality and health from national, regional, and local air quality actions"

- Areas of particular interest

    - Long-term, complex regulatory programs

    - Interventions at the local level

    - Ports and global transport

    - Methods development

- Thank you for your thoughtful comments - incorporated

- Preliminary applications being reviewed now;
  Full applications in May, review in June
  New studies announced during summer; work underway in 2020

- 3 to 5 studies to be funded; total $5 to 6 million for the program

Transparency: A continuing interest

Data Access: Key to scientific credibility and transparency

Longstanding HEI policy on data sharing

Recent Examples:

 RIOPA study – indoor, outdoor and personal exposures in three US cities → 40+ papers

 Data from MOSES – available since 2018

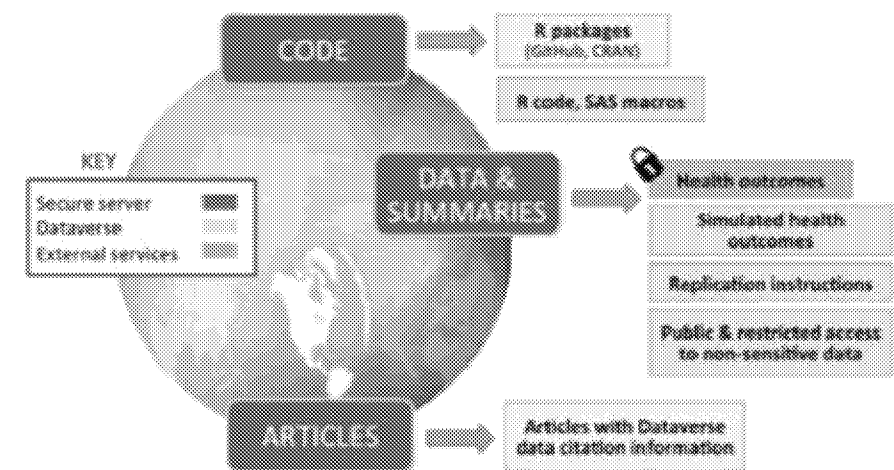 Dominici and other low exposure studies – built in component

 Wang (tunnel study) – data will be made public

Balancing Act:

 Complexity, effort and cost

 Privacy and intellectual issues

 Legal and regulatory issues – national and international

From: Francesca Dominici, Harvard
Chan School of Public Health

Global Health:
Placing Air Pollution in the Context of Broader Public Health Risks

- **Annual Global Burden of Disease Report (GBD) is gold standard for understanding health outcomes and risk factors worldwide**
  - Places air pollution systematically in the context of <u>all</u> other risks (e.g. smoking, diet, SES)
  - HEI leads the global air pollution analysis, conducts extended in-depth national analysis

- **Major HEI Products**
  - *Global Burden of Disease from Major Air Pollution Sources (GBD MAPS)*
    Identify source specific health impacts in China and India
    E.g. Power, industry, agriculture, transportation, kilns, household, dusts
    Understand transport in context of all sources
  - *The State of Global Air*
    Annual report and interactive website
    Presenting global and country-specific air pollution exposures and health impacts

Supplemental Funding: Hewlett and Bloomberg Foundations